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The reversal of the gender gap in education and relative divorce risks: A matter of alternatives in partner choice?

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Recent evidence from the United States suggests that the reversal of the gender gap in education was associated with changes in relative divorce risks: hypogamous marriages, where the wife was more educated than the husband, used to have a higher divorce risk than hypergamous marriages, where the husband was more educated, but this difference has disappeared. One interpretation holds that this may result from cultural change, involving increasing social acceptance of hypogamy. We propose an alternative mechanism that need not presuppose cultural change: the gender-gap reversal in education has changed the availability of alternatives from which highly educated women and men can choose new partners. This may have lowered the likelihood of women leaving husbands with less education and encouraged men to leave less educated spouses. We applied an agent-based model to twelve European national marriage markets to illustrate that this could be sufficient to create a convergence in divorce risks.

Keywords: divorce; repartnering; marriage market; education; sex ratio; gender; assortative mating; agent-based computational modelling

Introduction

Over the last few decades, Europe, North America, and many other parts of the world have experienced dramatic changes in the educational attainment of women relative to that of men. Until the 1970s, university education was mostly a domain of men, but participation of women has steadily increased since then. From around the 1990s, women have been surpassing men in terms of participation and success in higher education (Schofer and Meyer 2005). One consequence of this reversal is that long-standing patterns of educational assortative mating have changed. In most couples, the wife and husband have similar levels of educational attainment (homogamy). But, in the past, if there was a difference in educational attainment, the wife tended to be less educated than the husband (hypergamy). Today, if there is a difference, the wife tends to be more educated than the husband (hypogamy) (Esteve et al. 2012, 2016; Grow and Van Bavel 2015; De Hauw et al. 2017). The reversal of the gender gap in education is also likely to affect many other aspects of family life (Van Bavel 2012). In this paper, we explore how it may affect divorce risks, in particular

among marriages in which spouses differ in their educational attainment.

Earlier studies have shown that marriages in which the wife was more educated than the husband were less stable, giving rise to the concern that the increasing prevalence of hypogamy might increase the divorce rate (see Schwartz and Han 2014 for a review). However, Schwartz and Han (2014) showed that among recent cohorts in the United States (US), hypogamous marriages no longer exhibit a higher divorce risk than other marriage types. The authors suggested that this convergence might be the result of changing norms and family values. Hypogamy used to be uncommon and violated the norm that a husband should have a higher socio-economic status than his wife, in line with the male breadwinner family model. In recent years, as women's educational attainment has increased and their market participation has continued to expand, family values have become more egalitarian. This may have rendered hypogamy less non-normative and may have reduced the threat that a more educated spouse posed to a man's male identity.

We propose a different mechanism that may also lead to a convergence in the divorce risks of

hypogamous and hypergamous marriages, without the need to assume that norms and family values change. Our argument draws on the macrostructural-opportunity perspective on divorce, which highlights the availability of spousal alternatives as an important factor in divorce decisions (South et al. 2001). Research from this perspective builds on two central assumptions. First, individuals tentatively remain on the marriage market, even after marriage, and potentially leave their partner when they encounter more attractive marital alternatives. Second, the likelihood of people encountering marital alternatives increases if there is an oversupply of opposite-sex members on the marriage market. Together, these assumptions imply that the divorce rate increases if the sex ratio on the marriage market is imbalanced (South and Lloyd 1992, 1995; South 1995; South et al. 2001).

We investigated the implications of this mechanism when the sex ratio is specified by the educational attainment of potential mates. Research has consistently shown that educational attainment is an important dimension in mate selection (e.g., Kalmijn 1991; Lewis and Oppenheimer 2000), and the gender-gap reversal in education implies a declining ratio of highly educated men to highly educated women. Combined with the assumptions of the macrostructural-opportunity perspective, this can be expected to have implications for divorce risks, by affecting the number of attractive alternatives that people can choose from for repartnering. The likelihood of a highly educated woman who is married to a less educated man encountering an alternative with more education than her partner has substantially decreased over recent decades. Conversely, the likelihood of a highly educated man who is married to a less educated woman encountering a more educated alternative has increased. The divorce risk of hypogamous marriages may therefore have decreased, whereas the divorce risk of hypergamous marriages may have increased.

The foregoing reasoning appears intuitive, but the link between the marriage market and divorce patterns is more complex. One factor is that people's divorce decisions are highly interdependent (Chiapponi and Weiss 2006). For example, individuals who are single or divorced are more easily available for repartnering than individuals who are married (see Stauder 2006). Thus, if the marriage market contains many married individuals, people will be less likely to meet alternatives who are easily available for repartnering than when fewer people are married. To deal with such complexities, we made use of agent-based computational modelling and drew on the model of

educational assortative mating developed by Grow and Van Bavel (2015).

Agent-based modelling makes it possible to study two-sided partner search (in which the marriage market behaviour of both men and women needs to be considered simultaneously) by explicating the behavioural principles and interactions that underlie mate choice. This helps to alleviate some of the problems that other approaches to the study of two-sided partner search often face (for a discussion of some of these problems, see Willekens 2010). Agent-based modelling is a form of discrete-event simulation. As such, it is mathematically and computationally identical to demographic microsimulation. However, agent-based models traditionally have a stronger focus on studying the implications of theoretically motivated rules for individual behaviour and interactions, whereas microsimulations have a stronger focus on creating population projections based on empirical transition rates (Richiardi and Richardson 2016). This greater focus on theoretically motivated rules makes agent-based modelling attractive for the study of complex social dynamics, particularly when important actions and decision processes are largely unobservable, as is often the case with mate choice (Zinn 2016).

For the analysis reported in this paper, we extended the model by Grow and Van Bavel (2015). The original model was developed to study the link between the gender-gap reversal in education and assortative mating, and Grow and Van Bavel (2015) calibrated it to match observed patterns of educational assortative mating among cohorts born between 1940 and 1980 across twelve European countries. Although the original model was not developed with a focus on union stability, its assumptions about mate search and divorce are congruent with the assumptions that underlie our argument. This makes the model particularly attractive for our purposes. For the study of divorce, we adjusted two central aspects of the model. First, we traced each marriage that was formed, recording information such as the educational characteristics of the spouses, the simulation year in which the marriage was formed, year of dissolution, and reason for dissolution. The original model did not trace marriages; instead, it only focused on individual agents and their union status at a given point in time, as well as the characteristics of their partners (if they were partnered). Second, we relied on more realistic assumptions about fertility and mortality. The original model assumed that population size remained constant over time and that the risk of death increased with age at the same rate for both sexes. The

average life expectancy of men is lower than that of women and this can lead to a skewed sex ratio, particularly among older individuals (Dyson 2012). This, in turn, may affect their repartnering opportunities; we therefore addressed this issue by employing empirical fertility and mortality rates to generate more realistic age structures in our artificial populations.

We explored the proposed mechanism with data on the marriage market structure of the countries studied by Grow and Van Bavel (2015), for marriages formed between 1950 and 2004. For simplicity, we limited our analysis to heterosexual marriage and did not include non-marital cohabitation. We are aware that cohabitation has been on the rise in recent years and that the stability of cohabiting unions is often lower than that of marriages (Sobotka and Toulemon 2008; Schnor 2015). We assume, however, that the proposed mechanism would apply to both marriages and cohabitations.

In what follows, we first present the basic assumptions of the macrostructural-opportunity perspective and discuss the role that educational attainment plays in mate choice. Subsequently, we describe the model and the design of our computational experiments. We close with a discussion of our results and their implications for future research. Our results suggest that the gender-gap reversal may indeed lead to a convergence in the divorce risks of hypogamous and hypergamous marriages, by affecting the availability of marital alternatives from which people can choose. This convergence occurs even if we assume that the values and norms that surround family formation do not change. Yet, as discussed in the conclusion, the proposed mechanism can exist alongside mechanisms based on normative change and may even reinforce them.

The availability of marital alternatives and divorce

The assumption that marriages may dissolve when at least one partner encounters a more attractive alternative is consistent with the concept of marital bargains. This concept holds that '[j]ust as trading relationships dissolve when one of the parties locates a more profitable trading partner, many marriages dissolve when one of the spouses locates a more attractive marital partner' (South et al. 2001, p. 744). Yet, individuals do not always leave their partner when they meet a more attractive alternative. One important reason for this is the existence of partnership-specific investments, such as common

children and shared house ownership (Stauder 2006). These tend to increase the commitment to the current partner. Another reason can be legal structures or normative pressures that can make divorce less feasible and subjectively costlier (see Guttentag and Secord 1983; South and Lloyd 1995). However, even if such 'barriers' to separation exist, there is typically at least some chance that people will leave their spouse when they meet a more attractive alternative (Farber 1964; Levinger 1976; Becker et al. 1977).

If there are potentially more appealing alternatives on the marriage market, why would people marry a less attractive partner in the first place? Theories of marital search explain this with the uncertainty that partner search involves (England and Farkas 1986; Oppenheimer 1988). Men and women have specific preferences for the characteristics of their mates but they cannot know exactly if and when they will find the ideal partner. The less favourable the marriage market conditions are, the more difficult it becomes to find an attractive partner. The more time people have already invested in the search process, the riskier it becomes to pass up on potential spouses, given that the pool of available alternatives shrinks and their own market value decreases with age. This is particularly the case among women, given that they are judged more by youthful appearance than men (England and McClintock 2009). Therefore, individuals tend to lower their aspirations and become willing to accept partners who are 'less than perfect' as they grow older (Lichter 1990). Even if marriage market conditions are favourable, people may still partner with a less than perfect mate, if they invest little in mate search and settle for a partner early (see South 1995).

The macrostructural-opportunity perspective highlights that the real or perceived likelihood of people encountering attractive marital alternatives is partly determined by the numerical availability of opposite-sex members (South and Lloyd 1995). In a marriage market in which women outnumber men, men face a large pool of potential spouses and would therefore be more likely to encounter a more attractive alternative than when there is gender parity in numbers. As a consequence, they would be more likely to opt for divorce. The same applies to women when they are outnumbered by men.

Empirical evidence from the Western context largely supports the hypothesis of the macrostructural-opportunity perspective (Udry 1981; White and Booth 1991; South and Lloyd 1992, 1995; South et al. 2001; Rapp et al. 2015). For example, Udry (1981) showed that among husbands and

wives the mere perception that there are many attractive alternatives (assessed through survey items) is associated with an increase in divorce risks. Similarly, using the sex ratio in the local marriage market as a more objective measure of mate availability, South and Lloyd (1995) demonstrated that an oversupply of either sex is associated with an increase in divorce risks. One exception is a study by Lyngstad (2011), who found that in Norway an imbalanced sex ratio is associated with lower divorce risks. As an explanation, Lyngstad suggested that married people are more aware of the risk of divorce when their spouse faces many marital alternatives and they therefore increase their commitment and make concessions to maintain the marriage. Lyngstad's data do not allow for inspecting this mechanism and the opportunity-based mechanism separately, but it is possible that both operate simultaneously. So far, most of the existing evidence suggests that the opportunity-based mechanism tends to dominate.

Educational attainment and the attractiveness of marital alternatives

Early marriage market studies have focused on age as an important determinant of mate attractiveness (e.g., Glick and Landau 1950). More recent research has also highlighted the importance of people's cultural and economic resources (see Kalmijn 1998; Lewis 2016). Cultural resources include 'values and behaviours, such as child-rearing values, political attitudes, cultural literacy, taste in art and music, and styles of speech' (Kalmijn 1994, p. 426). Similarity in such values and behaviours can lead to mutual reinforcement of world views, generate feelings of social confirmation, and facilitate the organization of joint activities within couples. As a consequence, people often prefer partners with similar cultural resources (DiMaggio and Mohr 1985). Economic resources, such as income and property, produce economic well-being and status. Such resources are typically shared within couples and people therefore tend to prefer partners with high economic resources, as this can improve their own economic well-being and status (Kalmijn 1994).

Education encompasses both economic and cultural aspects. It is commonly assumed to be 'the most important determinant of occupational success in industrialized societies [... and] it reflects cultural resources influencing individuals' preference for specific partners' (Blossfeld 2009, p. 514). This link with economic and cultural resources is one reason

why education is an important factor in mate selection and can explain why men and women tend to prefer spouses with a similar level of education to themselves and to prefer more educated spouses over less educated spouses. A spouse with a similar level of education is attractive because of the likely similarity in cultural resources, but a more educated spouse may also be attractive because of the higher economic resources that often come with higher educational attainment. A less educated spouse, by contrast, is less attractive given the lack of similarity in cultural resources and the lack of economic resources.

Modelling the link between the gender-gap reversal in education and divorce

Our model is a two-sex model (see Willekens 2010) that simulates mate search over the life courses of several cohorts of people (agents). Agents are born, grow older, enter school, enter the marriage market, leave education, reproduce, and die at some point. The model makes three assumptions that are central for our purposes: (1) individuals have preferences for mates with certain characteristics and can choose to leave their partner when they encounter a more attractive alternative; (2) the similarity in cultural resources that comes with similarity in education, and the economic resources that come with high education, increase the attractiveness of the available alternatives; and (3) the likelihood of people encountering attractive alternatives is largely determined by the structure of the marriage market.

The model takes into account the fact that education is usually associated with cultural and economic resources. In line with earlier research (Kalmijn 1994), it approximates people's cultural resources by their educational level and their economic resources by their lifetime earnings prospects. Thus, agents feel attracted to opposite-sex members who are similar to them in educational attainment, but they also feel attracted to those who have high earnings prospects. Education and earnings prospects are positively correlated, but this correlation differs between men and women. Furthermore, the model also considers age to be an important determinant of mate attractiveness. It assumes that men feel most attracted to women who are in their mid-20s (other things being equal), whereas women feel most attracted to men who are slightly older than themselves (England and McClintock 2009; Skopek et al. 2011).

Agents enter the marriage market and start looking for a spouse when they have reached a marriageable age (at 16 years). The search takes the form of meetings with opposite-sex members who are drawn randomly from the marriage market. The model considers that the educational system tends to structure the daily activities and meeting opportunities of adolescents and young adults. In particular, while in education, people have an increased likelihood of interacting with those who are currently attending at the same educational level (Mare 1991). Thus, agents progress through the educational system and, as long they are in education, they are more likely to meet somebody who is currently attending at the same educational level, rather than somebody who is attending at a different level or has left education already.

Whenever two agents meet, both need to decide whether they want to start dating; agents who are dating need to decide whether they want to marry. These decisions are modelled probabilistically, based on the assumptions of maximizing and risk-averse behaviour. That is, agents become more likely to accept each other for dating and marriage, the more attractive they perceive each other to be. Yet, agents' aspirations for the attractiveness of their partner decrease as they grow older, given that for both men and women the pool of alternatives usually shrinks with age. This means that in the model, younger agents are more selective in choosing a mate than older agents. This decrease in selectiveness with age is stronger among women, given that their attractiveness to men tends to decrease with age (see Lichter 1990; England and McClintock 2009).

The model accounts only for divorce caused by repartnering. It does not consider divorce for other reasons, such as relationship problems (Amato and Previti 2003). Thus, agents tentatively remain on the marriage market, even after marriage, and continue to meet opposite-sex members. If they encounter an alternative that is more attractive than their current partner, there is a chance that they choose to divorce and repartner. Both the likelihood of agents meeting somebody new and of them leaving their current partner decrease with the length of their current relationship, representing the effect of partnership-specific investments that increase over time (see Stauder 2006).

We implemented the model in NetLogo (Wilensky 1999) and the code can be obtained from <https://www.openabm.org/model/5105>, together with a more detailed model description (Appendix A) and results of supplementary analyses to determine the

number of simulation runs that were necessary to obtain reliable results (Appendix B).

Agent characteristics

The model proceeds in discrete time steps and all time-related elements are expressed in these steps. Ten time steps represent one simulation year. Each agent, i , can be described by their gender, g_i (1 = male or 2 = female); age, a_i (measured in time steps); the highest educational level that they will ever attain, s_i (1 = no education, 2 = primary education, 3 = secondary education, or 4 = tertiary education); earnings prospects, y_i (expressed in five ordered categories); educational enrolment status, r_i (1 = not in the educational system yet, 2 = in primary education, 3 = in secondary education, 4 = in tertiary education, or 5 = finished education); relationship status, l_i (1 = single, 2 = dating, 3 = married, or 4 = divorced); the time they have already been in a relationship with their current partner, c_i (measured in time steps); and the ideal age they prefer in a partner, u_i (expressed in time steps). Table 1 provides an overview of all agent variables and Table 2 provides an overview of all other model parameters. The parameter values shown in Table 2 are based on the calibration experiments reported in Grow and Van Bavel (2015), subject to some adjustments to align them with the new input data that we describe later.

Agents' states of g_i , s_i , and y_i are assigned when they enter the simulation at birth and remain stable over their life course. Their states of s_i and y_i are assigned probabilistically, contingent on their gender and birth year, based on empirical input data (see details later).

Agents' initial states of a_i , r_i , l_i , and c_i are also assigned when they enter the simulation, but these states can change over their life course. Agents' ages (a_i) are initialized as zero and increase by one at the end of each time step. Given that ten time steps represent one simulation year, agents age by one year every ten time steps. Each agent's relationship status (l_i) is initialized as single and is updated every time they start a new relationship, get married, break up with their current date, get divorced, or their partner dies. Correspondingly, the length of their current relationship (c_i) remains at zero for as long as they are single or divorced and increases by one at the end of each time step from the moment they start dating. This increase continues when a dating relationship turns into a marriage. Every time agents experience a break-up (after

Table 1 Overview of agent variables

Variable	Description	States
g_i	Gender	1 = male 2 = female
a_i	Age	Time steps: $\in \{0, 1, \dots, A_{\max}\}$
s_i	Educational attainment	1 = no education 2 = primary education 3 = secondary education 4 = tertiary education
r_i	Educational enrolment status	1 = not in the educational system yet 2 = in primary education 3 = in secondary education 4 = in tertiary education 5 = finished education
l_i	Relationship status ¹	1 = single 2 = dating 3 = married 4 = divorced
c_i	Duration of current relationship	Time steps: $\in \{0, 1, \dots, A_{\max} - 160\}$
u_i	Ideal age that agent i prefers in a partner ²	Time steps: $\in \{0, 1, \dots, A_{\max} + 25\}$ (for male agents fixed at 240, for female agents equal to $a_i + 25$)
y_i	Earnings prospects	$\in \{1, 2, 3, 4, 5\}$

¹In contrast to Grow and Van Bavel (2015), we added the category ‘divorced’ to identify agents who have experienced divorce but not yet repartnered.

² u_i is denoted α_i in Grow and Van Bavel (2015).

Note: Ten time steps represent one simulation year; for example, a value of 160 represents 16 years.

dating) or divorce (after marriage), or when their partner dies, the value of c_i is set to zero. An agent’s educational enrolment status (r_i) is updated as they progress through the educational system, based on the age thresholds shown in Table 3. Every time agents reach the age at which they exit one stage ($A_{ex,r}$) and enter the next ($A_{en,r}$), the

value of r_i is updated accordingly. Agents leave education once they have finished the level that corresponds with their state s_i . The only exceptions are agents with $s_i = 2$ (primary education), who transition from primary to secondary education and leave school at age 16 ($a_i = 160$). This takes into account the fact that a minimal number of years in

Table 2 Overview of model parameters

Parameter	Description	Values in experiments
I	Total number of agents in the initial population ¹	1,000
$A_{en,r}, A_{ex,r}$	Age at which agents enter and exit a given educational level r	See Table 3
A_{marr}	Age at which agents enter the marriage market	160
S_{\max}	Maximal educational attainment of agents	4
Y_{\max}	Maximal earnings prospects of agents	5
A_{\max}	Maximal age of agents ²	1,100
w_s^m, w_s^f	Importance that male and female agents attach to similar education of partners	0.934, 0.385
w_y^m, w_y^f	Importance that male and female agents attach to high earnings prospects of partners	1.025, 1.201
w_a^m, w_a^f	Importance that male and female agents attach to the age of partners ³	6.887, 14.895
β^m, β^f	Commitment parameter for male and female agents	0.015, 0.015
σ^m, σ^f	Age pressure parameter for male and female agents	0.0015, 0.0030
δ	Structuring effect of the educational system	0.9

¹In contrast to Grow and Van Bavel (2015), we increased the number of agents from 500 to 1,000 to increase the number of observations per run, given that divorce happens less often than marriage.

²In contrast to Grow and Van Bavel (2015), we increased the value of $A_{\max} = 800$ to 1,100, to make full use of the age range covered by the empirical mortality rates that we used.

³Because of the increase in A_{\max} compared with that used in Grow and Van Bavel (2015), we have multiplied the original values of w_a^m and w_a^f by $1,100/800 = 1.375$. In this way, we were able to consider values of $a_i > 800$, without altering the functional relationship between $u_i - a_i$ and v_{ij} for values of $a_i \leq 800$, as defined by Grow and Van Bavel.

Note: Ten time steps represent one simulation year; for example, a value of 160 time steps represents age 16.

Table 3 Overview of ages at which agents transit between educational levels

Educational level	r	$A_{en,r}$	$A_{ex,r}$
Not in the educational system yet	1	0	60
In primary education	2	60	100
In secondary education	3	100	190
In tertiary education	4	190	240

Notes: r is the educational enrolment status; $A_{en,r}$ is the age at which agents enter a given enrolment status; $A_{ex,r}$ is the age at which agents leave a given enrolment status. Ten time steps represent one simulation year; for example, a value of 100 represents ten years of age.

the educational system is usually mandatory for those who participate in education (e.g., adolescents often have to attend secondary school for some years, even if they do not complete this level successfully). Agents with $s_i = 3$ (secondary education) stay in education until age 19 ($a_i = 190$) and then leave the educational system, whereas agents with $s_i = 4$ (tertiary education) transition to college/university at this age and stay at this level until age 24 ($a_i = 240$).

Finally, agents are also assigned the age that they prefer in a partner (u_i) when they enter the simulation. For male agents, this value remains fixed at age 24 ($u_i = 240$) over their entire life course. For female agents, u_i is updated at each time step, so that they always prefer partners who are 2.5 years older than themselves ($u_i = a_i + 25$).

Partner preferences

Partner choice is based on the overall attractiveness that a given agent, i , perceives in another agent, j . This attractiveness is expressed in a single number, the mate value v_{ij} . It combines information about the attractiveness of j in terms of educational attainment (representing cultural resources), earnings prospects (representing economic resources), and age. Earlier research suggests that low attractiveness in one or more important partner characteristics cannot easily be substituted with high attractiveness in other characteristics (Li et al. 2002; Li and Kenrick 2006). In the literature on multi-criteria decision-making, such interdependence between criteria is often expressed by multiplicative exponential weighting functions (introduced by Cobb and Douglas 1928), and the model uses such a function to determine v_{ij} . Its form is

$$v_{ij} = \left(\frac{S_{\max} - |s_i - s_j|}{S_{\max}} \right)^{w_s} \left(\frac{y_j}{Y_{\max}} \right)^{w_y} \left(\frac{A_{\max} - |u_i - a_j|}{A_{\max}} \right)^{w_a} \quad (1)$$

where S_{\max} , Y_{\max} , and A_{\max} define the maximal education, earnings prospects, and age that agents can

reach and the parameters w_s , w_y , and w_a govern how much agents ‘penalize’ deviations from their ideals in each dimension. The value of v_{ij} can vary continuously between zero and one. The value of v_{ij} comes closer to one, the more similar i and j are in their educational attainment, the higher the earnings prospects of j are, and the closer j is to the age that i desires in a partner (u_i). Deviations from these ideals decrease the value of v_{ij} , and this decrease is stronger at higher values of w_s , w_y , and w_a .

Table 2 shows that male (m) and female (f) agents differ in the weight they attach to each of the three mate characteristics (w_s , w_y , and w_a). The parameterization implies that females penalize deviations from the ideal age more than males. This is in line with the observation that, as men grow older, they tend to marry women who are increasingly younger than themselves, but also increasingly further away from the ideal age of 24 years (implying a higher tolerance), whereas women tend to marry men who are two to three years older, regardless of their own age (implying a lower tolerance) (see England and McClintock 2009). The parameterization also implies that female agents attach relatively more importance to economic resources than to similarity in cultural resources (represented by earnings prospects and educational attainment, respectively). Male agents, by contrast, attach similar importance to both dimensions. This is in line with the notion that in the past, women often had less access to economic resources than men and therefore often attached more importance to the economic potential of their partners (Becker 1981). Evidently, this gap in financial resources has decreased with the increase in women’s educational attainment relative to that of men and with the parallel increase in labour force participation of females (see England 2010). Also, there is some evidence that differences between men’s and women’s partner preferences have somewhat decreased in recent years (Zentner and Eagly 2015). Yet, a considerable gap often still exists in spouses’ incomes to the disadvantage of women

(Klesment and Van Bavel 2017) and empirical research suggests that women still tend to attach more importance to economic resources in their partners than men do (e.g., Li and Kenrick 2006; Hitsch et al. 2010).

Earlier agent-based models generally used a single value to represent how attractive one agent perceives another agent overall. However, many of these models did not explicitly model the individual characteristics from which this overall attractiveness was derived (e.g., Simão and Todd 2002, 2003). Those models that explicitly modelled these characteristics (e.g., French and Kus 2008; Hills and Todd 2008) typically added or averaged the attractiveness that was derived from different characteristics. The model by Grow and Van Bavel (2015) was, to the best of our knowledge, the first to implement non-additive interdependence between central partner characteristics, as discussed earlier in this subsection.

Partner search

We consider two stages of partner search: (a) ‘not seeking a spouse’; and (b) ‘seeking a spouse’. The latter stage involves the actual search process (governed by equations (2), (3a), and (3b) presented in this subsection), as well as dating, marriage, and divorce decisions (governed by equations (4) and (5) presented in the next subsection).

From the moment agents are born, they are in the stage of not seeking a spouse and they remain in this stage until they reach the age of 16 years. At this point, they enter the marriage market and start looking for a spouse ($A_{\text{marr}} = 160$). This transition is irreversible and agents remain in this stage for the rest of their lives, even after they have married (but their search effort can decrease, as described later), which is in line with the assumptions of the macrostructural-opportunity perspective. Furthermore, partner search takes place irrespective of agents’ educational enrolment status (that is, agents who are in education and those who have left education already engage in similar search processes).

Agents who are in the stage of seeking a spouse and currently have no partner invest full effort into finding a spouse, whereas agents who already have a partner reduce this effort, contingent on the length of their relationship. This is consistent with the observation that the number of contacts that men and women have with opposite-sex members tends to decrease with relationship length (Rapp et al. 2015). The search effort is represented by the probability that agents will actively seek out an

opposite-sex member in a given time step. It is determined as

$$Pr(i \text{ seek}) = e^{-(c_i \beta)}. \quad (2)$$

In equation (2), β is a ‘commitment parameter’ that governs the effect that the length of i ’s current relationship has on the probability that the agent will try to meet somebody. For single and divorced agents, c_i is always zero and the probability that they will seek out somebody is thus always one. As Table 2 shows, the value of β is positive and is the same for male and female agents, and equation (2) therefore implies that an agent’s inclination to seek out alternatives to their current partner decreases exponentially with the length of their current relationship and approaches zero after about 25–30 simulation years. This is inspired by the observation that few divorces occur after more than 25–30 years of marriage (see Kulu 2014). Note that $Pr(i \text{ seek})$ can never become zero; yet, for technical reasons, values between zero and 10^{-324} are considered equal to zero in the simulation. Earlier agent-based models of partner search have made similar assumptions about how the length of a relationship affects agents’ search efforts (e.g., Simão and Todd 2002, 2003).

If agent i is seeking a partner in the current time step, an opposite-sex member, j , is selected randomly from one of two sets of marriage market members: agents who have the same educational enrolment status as i (i.e., $r_i = r_j$), or agents who have a different educational enrolment status (i.e., $r_i \neq r_j$). The probability with which each set is chosen is determined by the ‘structuring parameter’ δ ($0 \leq \delta \leq 1$), so that

$$Pr(r_i = r_j) = \delta \quad (3a)$$

and

$$Pr(r_i \neq r_j) = 1 - \delta. \quad (3b)$$

The closer the value of δ is to one, the more likely agents are to meet somebody with the same educational enrolment status; conversely the closer the value of δ is to zero, the more likely agents are to meet somebody with a different enrolment status. In both cases, j is randomly selected from all agents in the respective set. As Table 2 shows, the chosen value for δ (0.9) implies that while in education, agents mostly encounter people who are currently attending at the same educational level. Conversely, agents who have left education already are most likely to meet agents who also have left education.

Dating, marriage, and divorce decisions

Whenever two agents meet, they need to decide whether they want to start dating. Dating can lead to marriage and marriages can end in divorce if agents meet an alternative who is more attractive than their current partner and who also wants to start dating them. Thus, in the model, divorce is always the result of repartnering.

More specifically, whenever agent i meets an opposite-sex member j , both assess each other's mate value (i.e., v_{ij} and v_{ji} , respectively) and use this value to decide whether they want to start dating the other. For illustration, we focus here on the decision process from i 's point of view. If agent i has no partner (i.e., $l_i = 1$ or 4), they perceive any opposite-sex member as a potential spouse and therefore always consider dating j . By contrast, if i is currently dating or married (i.e., $l_i = 2$ or 3), they consider as a potential spouse only those j whose mate value is higher than that of their current partner, k . If i encounters such an alternative, there is a chance that they choose to leave (if i is dating) or divorce (if i is married) their current partner. Formally, the probability that i is willing to date j (and to leave or divorce their current partner, k , if they have one), is determined by

$$Pr(i \text{ willing to date } j) \begin{cases} 1 - e^{-(a_i v_{ij} \sigma)} & \text{if } (l_i = 1 \text{ or } 4) \\ (1 - e^{-(a_i v_{ij} \sigma)})e^{-(c_i \beta)} & \text{if } (l_i = 2 \text{ or } 3) \text{ and } v_{ij} > v_{ik} \\ 0 & \text{if } (l_i = 2 \text{ or } 3) \text{ and } v_{ij} \leq v_{ik} \end{cases} \quad (4)$$

where σ governs the 'age pressure' that agents experience when looking for a partner as they become older. The first line of equation (4) implies that for agents who have no partner, their willingness to start dating j increases with j 's mate value and with i 's age (assuming that $\sigma > 0$). The second line implies that if agent i has a partner, k , and if the mate value of the alternative, j , is higher than that of k , i 's willingness to date j (and to leave k for this) is attenuated by the length of their current relationship with k , as indicated by c_i (assuming that $\beta > 0$). Yet, as the third line indicates, if i has a partner, k , and if the mate value of j is lower than, or equal to, that of k , then i will not consider starting to date j . Finally, two agents only leave or divorce any current partners and start dating each other when both are willing to date. This implies two independent decision processes, in which equation (4) is applied separately to i and j .

The longer agents have already been dating their current partner, the more willing they become to marry and therefore to propose marriage to or accept a marriage proposal from their partner.

When agent i (or k) proposes marriage to their current partner, k (or i), the proposal remains intact until k (or i) agrees to marry, or until one of them terminates the relationship or dies. They get married at the moment both agree to marry. The probability that agent i proposes to k , or is willing to accept a proposal from k , is calculated as

$$Pr(i \text{ proposes/accepts marriage with } k) = (1 - e^{-(a_i v_{ik} \sigma)})(1 - e^{-(c_i \beta)}). \quad (5)$$

The first term of equation (5) holds that agents are more likely to propose marriage to or accept a marriage proposal from their partner, the higher the mate value of their partner (v_{ik}) and the older they are (a_i), assuming that there is some age pressure ($\sigma > 0$). This parallels the notion implemented in equation (4), that the more attractive an individual finds a given opposite-sex member, the less hesitant they are to form a committed relationship, and the notion that the older they are, the less hesitant they will be to form such a relationship in general. The second term holds that as the length of the relationship (c_i) increases, i becomes more likely to propose marriage to or accept a proposal from k (assuming that $\beta > 0$). This is achieved by subtracting $e^{-(c_i \beta)}$ (which is exponentially decreasing in c_i if $\beta > 0$) from one. Like equation (4), this implements the notion that relationship-specific capital tends to increase with relationship length, which renders outside alternatives less attractive and makes individuals less hesitant to form a permanent bond.

As Table 2 shows, in these decision processes female agents experience a stronger age pressure (σ) than male agents. This implements the notion that both men and women have access to a smaller pool of alternatives as they grow older, but women suffer an additional penalty owing to men preferring women who are in their mid-20s, which increases women's pressure to find a partner while young (see England and McClintock 2009).

Note that the ways in which the model implements effects of agents' age, relationship status, and relationship length on their willingness to start dating a given opposite-sex member are similar to implementations in earlier models of partner search (e.g., Simão and Todd 2003; Hills and Todd 2008). Note further that we have adjusted the original model by Grow and Van Bavel (2015), so that every time two agents marry, a unique marriage record is created that provides information about the characteristics of the spouses and the year in which the marriage was formed. When the two agents separate or one of them dies, the year of

dissolution is added to the record, including the dissolution reason (i.e., divorce or death of one partner).

Fertility and mortality

As indicated earlier, we adjusted the model presented in Grow and Van Bavel (2015) to incorporate empirical fertility and mortality rates (see sources in the next section) that enabled us to model annual fertility rates among female agents aged 12–55 years ($a_i \geq 120$ and $a_i \leq 550$) and annual mortality rates among all agents aged 0–110 years ($a_i \geq 0$ and $a_i \leq 1,100$). These rates translate into country-, period-, gender-, and age-specific probabilities for giving birth and dying that are applied to each agent at the beginning of each simulation year. We assume that 105 males are born for every 100 females (Guilmoto 2012), so that there is a 0.512 probability that a new born agent is male.

Experimental set-up and measures

The model in Grow and Van Bavel (2015) used empirical data and projections provided by the International Institute for Applied Systems Analysis/Vienna Institute of Demography (IIASA/VID) (Lutz et al. 2007; KC et al. 2010) and the European Community Household Panel for initializing agents in terms of educational attainment and earnings prospects in twelve European countries. Figure 1 shows trends in the sex ratio among the highly educated at age 30–49 years between 1970 and 2015 in these countries, based on the IIASA/VID data. The figure illustrates that, in most countries, there used to be many more men than women with higher educational attainment. Yet, over time, the number of women with higher educational attainment increased relative to that of men. By 2015, in most countries the sex ratio among the highly educated was either balanced or the imbalance had turned to the favour of women. Sweden is the only country in which the sex ratio was already balanced in 1970, and Germany is the only country in which highly educated men still outnumbered highly educated women in 2015. Hence, the input data capture the reversal of the gender gap in educational attainment.

For our analysis, we also used data obtained from the Human Fertility Database (2016)/Human Fertility Collection (2016) and the Human Mortality Database (2016) to implement realistic fertility and mortality rates (see Appendix A at [https://www.](https://www.openabm.org/model/5105)

[openabm.org/model/5105](https://www.openabm.org/model/5105) for more details). The combined data enabled us to study mate search under plausible marriage market conditions over the period 1921–2012 in the twelve countries shown in Figure 1. We focused on the dissolution risk for marriages formed between 1950 and 2004, and the simulation period covered the years 1921–2064. We chose 2064 as the stopping year to avoid problems associated with possible censoring among later marriage cohorts. We used the input data from the year 2012 in all subsequent simulation years.

We focused on the share of marriages in a given marriage cohort that had dissolved by the end of the simulation runs. We were particularly interested in the relative divorce risks of hypogamous vs. hypergamous marriages and assessed this by

$$R = \frac{A}{B} \quad (6)$$

where A and B refer to the average shares of hypogamous and hypergamous marriages that had dissolved across runs. On this measure, a value larger than one indicates that hypogamous marriages are more likely to dissolve than hypergamous marriages; a value smaller than one indicates that hypogamous marriages are less likely to dissolve; and a value of one means that there is no difference in the likelihood of divorce.

We measured the structure of the marriage market in which divorces occurred with the F -index proposed by Esteve et al. (2012). This index expresses the educational advantage that women have in a population as the probability that any randomly selected woman will be more educated than any randomly selected man. Accordingly, a higher F -index value indicates a higher educational advantage of females. The measure is calculated as

$$F = \frac{p_4^f(p_3^m + p_{1+2}^m) + p_3^f p_{1+2}^m}{1 - (p_{1+2}^f p_{1+2}^m + p_3^f p_3^m + p_4^f p_4^m)} \quad (7)$$

where $p_{s_i}^m$ and $p_{s_i}^f$ refer to the proportions of men and women who belong to each category of s_i . The measure ranges from zero to one. A value of zero indicates that no woman is as educated as, or more educated than, any man; a value of one indicates that no man is as educated as, or more educated than, any woman; and a value of 0.5 indicates that men and women are educated to a similar level on average. We calculated F for a given year based on the IIASA/VID data and focused on men and women in the age range 20–49 years, given that this is typically the prime age for (re)marriage. Note that in equation (7) (and all other calculations

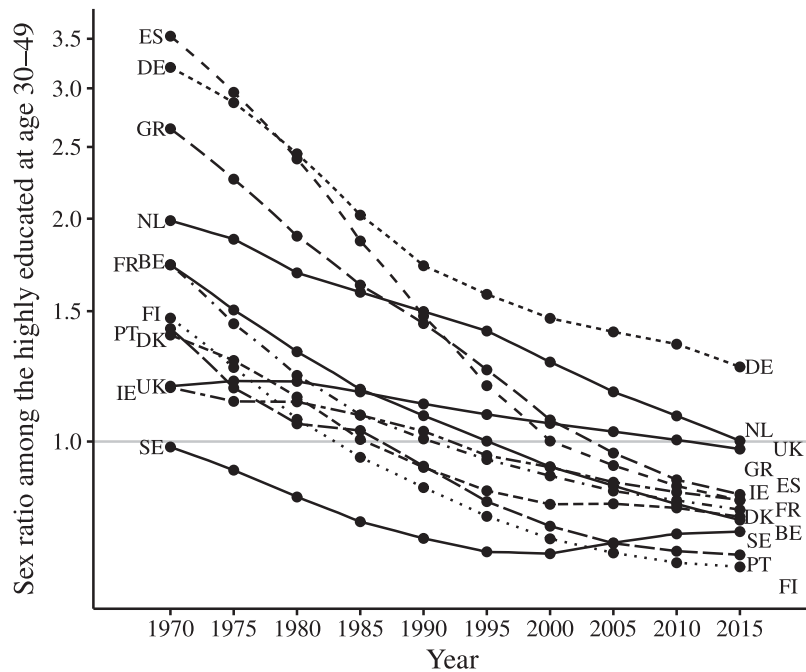


Figure 1 Sex ratios among highly educated individuals aged 30–49 years in twelve European countries, 1970–2015

Notes: Selected countries are Belgium (BE), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), the Netherlands (NL), Portugal (PT), Sweden (SE), and the United Kingdom (UK); the selection is based on Grow and Van Bavel (2015). The y-axis is log-transformed, so that a given ratio and its inverse are shown at the same distance from the equal numbers case (i.e., from number of men/number of women = 1). High education is operationalized as ISCED-97 5–6, comprising the first (e.g., bachelor's degrees) and second stages (advanced research qualifications, e.g., PhD degrees) of tertiary education.

Source: Own calculations based on the global educational trend scenario in the reconstructions and projections of educational attainment by country, year, gender, and five-year birth cohort provided by the IIASA/VID.

reported in the results), educational categories '1' and '2' are combined, given that category '1' was virtually empty in most countries and years.

All results are based on averages obtained from 1,000 independent simulation runs per country (see Appendix B at <https://www.openabm.org/model/5105> for an analysis to determine this number of runs). Each run was preceded by a burn-in phase of 600 simulation steps to ensure that agents who started looking for a partner at the beginning of the main simulation phase did so in a plausible marriage market (see Appendix A at <https://www.openabm.org/model/5105> for details).

Results

Figure 2 plots the average shares of marriages that had dissolved by the end of the simulation runs across countries by marriage cohort and marriage type. About 13 per cent of all marriages ended in divorce and this value tended to increase from about 12 per cent in the 1950–54 marriage cohort,

to a maximum of about 14 per cent among marriages formed in 1985–89. By comparison, according to Eurostat (1997), the share of marriages that had formed in 1960 and ended in divorce across selected European countries was 14 per cent, ranging from 2 per cent in Spain to 29 per cent in Denmark. For marriages formed in 1980, this value had increased to 27 per cent, ranging from 7 per cent in Italy to 46 per cent in Sweden. Evidently, this comparison with empirical data is complicated by the fact that the model only considers divorce due to repartnering, whereas not all divorces occur because of a third person. Even with data on reasons for divorce, a comparison is difficult, because there can be multiple reasons involved in a given divorce decision and concerns for social desirability may lead to under-reporting of marital infidelity and new relationships. However, the existing evidence suggests that the model outcomes are plausible. For example, Amato and Previti (2003) found in a longitudinal survey of US couples that marital infidelity was reported as one reason for divorce among about 22 per cent of couples that had divorced.

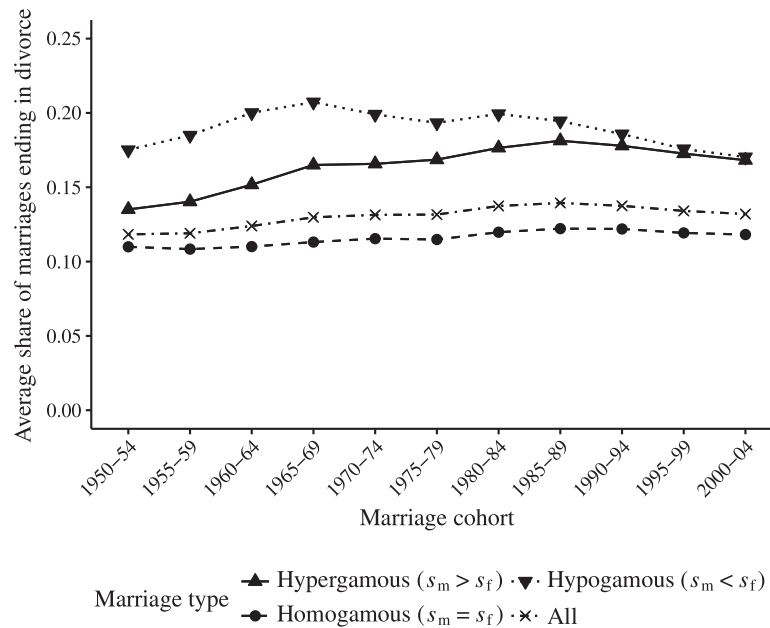


Figure 2 Average shares of different marriage types that had ended in divorce by the end of the simulation runs, by marriage cohort; simulations for twelve European countries combined

Note: We first calculated the mean shares for the different marriage types that had dissolved across runs within countries and then calculated the averages of these means across countries.

Source: Own calculations based on the outcomes of our main simulation experiment.

Considering that in the US about 50 per cent of all first marriages end with separation or divorce within 20 years (Copen et al. 2012), this implies that about 11 per cent of first marriages end in divorce because of a third person.

Figure 2 shows that couples in homogamous marriages were least likely to experience divorce, although their divorce risk slightly increased up to the 1985–89 marriage cohort. Like the empirical trends reported by Schwartz and Han (2014) for the US, in our simulations hypergamous marriages were less likely to dissolve than hypogamous marriages in early marriage cohorts, but this difference decreased in more recent cohorts and disappeared by the 2000–04 marriage cohort.

Figure 2 shows averages across the countries and masks between-country variation. Figure 3 shows the results separately for each country and focuses on the relative divorce risk (R). In many countries, the value of R started above one in early marriage cohorts and approached one in later cohorts. In Denmark, Finland, and Portugal, R even became lower than one. This means that relative to hypergamous marriages, the divorce risk for couples in hypogamous marriages tended to decrease over successive cohorts and, in some countries, hypogamous marriages even became *less* likely to divorce than hypergamous marriages. Sweden is the only country in which the divorce risk of hypogamous

marriages was lower than that of hypergamous marriages in all cohorts. But even this already low relative risk decreased over successive cohorts. The only countries that did not show a clear decrease in R were Ireland and the United Kingdom (UK); this is most likely caused by the fact that the changes in the sex ratio among the highly educated were smallest in these countries, as can be seen in Figure 1.

The results suggest that we might expect the divorce risks of hypogamous and hypergamous marriages in Europe to converge and we argue that this could result from changes in women's educational attainment relative to that of men. To assess this more directly, we needed to measure the structure of the marriage market in which divorces had occurred. This measurement is complicated by the fact that even if two marriages have formed at the same point in time, they may have dissolved at different points in time, and therefore under different conditions. To deal with this issue, we used the average time from marriage to divorce as a reference for approximating the structure of the marriage market in which divorces had occurred.

Figure 4 shows the shares of marriages that had dissolved across all simulation runs by marriage duration. The distribution shows a right skew, as also observed in empirical research (e.g., Kulu 2014). The overall average was around 3.6 simulation

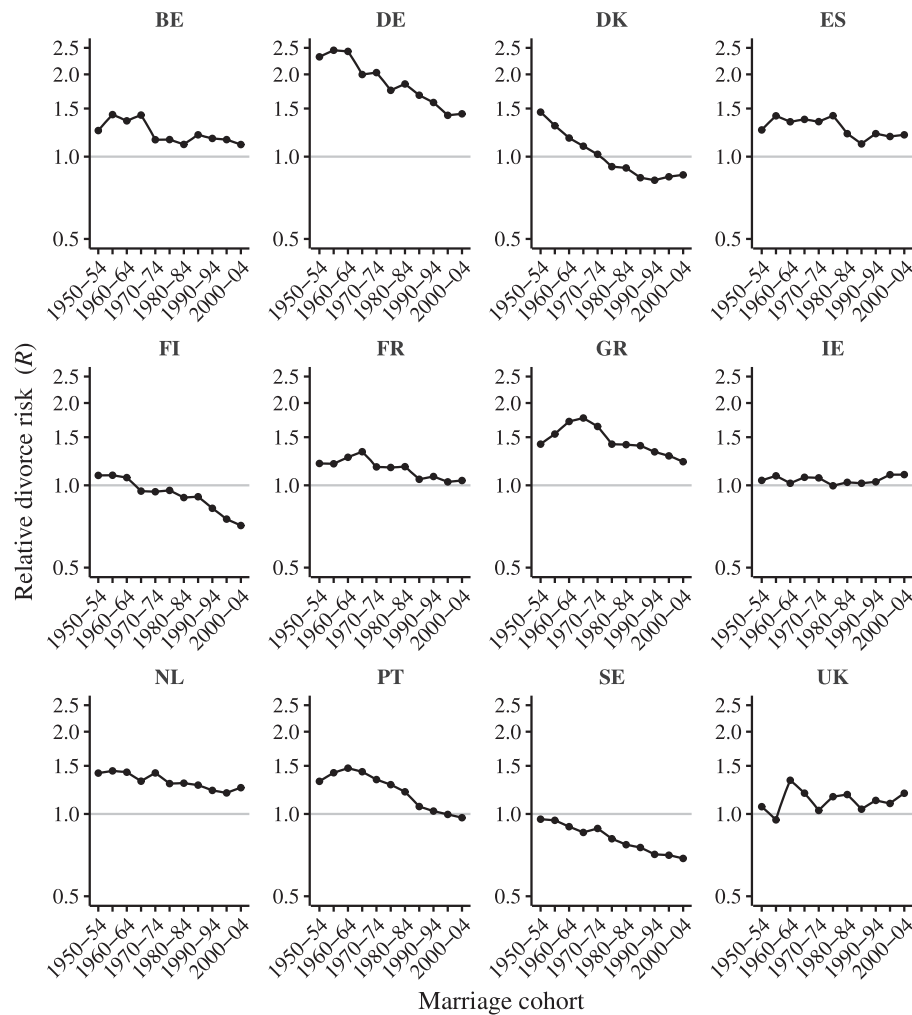


Figure 3 Relative divorce risk (R) for hypogamous ($s_m < s_f$) vs. hypergamous ($s_m > s_f$) marriages, by marriage cohort; simulations for twelve European countries

Notes: We first calculated the average shares of different marriage types across runs within countries and then used these averages to calculate R . The y-axis is log-transformed, so that a given ratio and its inverse are shown at the same distance from the equal risk case (i.e., from $R = 1$).

Source: As for Figure 2.

years, decreasing from around 4.1 to 3.3 years between the 1950–54 and 2000–04 marriage cohorts. A comparison with empirical data is also difficult here. Stauder (2006), for example, reported for his representative sample of the German population aged 18–55 years in 2000, that unions that had dissolved and involved immediate repartnering by the respondent lasted between 3.0 years (among those born after 1965) and 5.2 years (among those born up to 1965). Yet, Stauder did not distinguish between marital and non-marital unions and the data only included unions that had lasted at least one year. Similarly, repartnering was only considered when the follow-up relationship had lasted at least one year. Despite this caveat, the comparison suggests that the model outcomes are plausible.

To assess the relevant marriage market structure, we calculated the F -index for each marriage cohort one to five years after marriage. For example, for marriages formed in 1950–54, we calculated F for the year 1955. Given that the IIASA/VID data only provide information from 1970 onwards, we approximated the F -index for 1955, 1960, and 1965 with the data from 1970, focusing on the age groups that would have been 20–49 years of age in the respective year. Figure 5 plots the association between F and R for each marriage cohort in each of the twelve countries. As female agents became increasingly more educated than male agents (i.e., as F increased), the risk that hypogamous marriages dissolved, compared with hypergamous marriages, decreased (i.e., R decreased). This supports our argument.

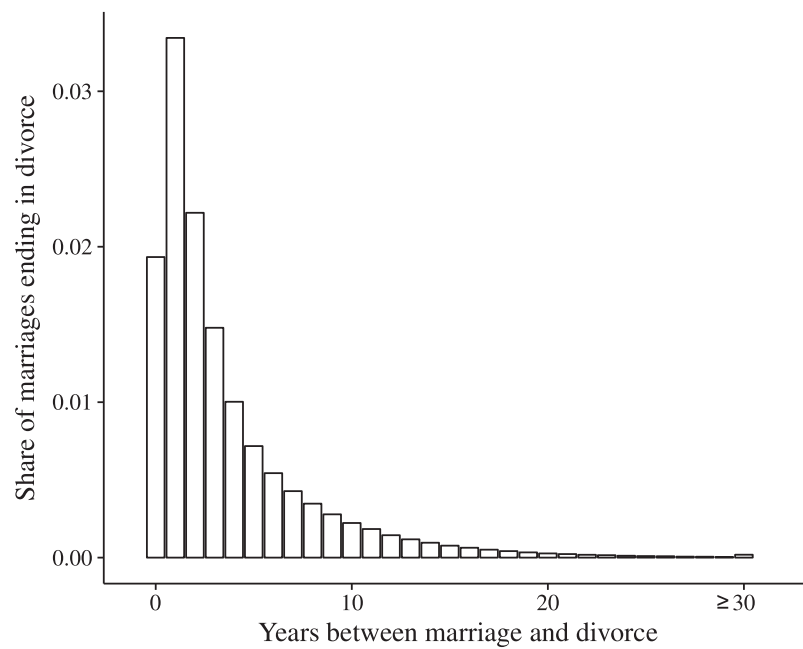


Figure 4 Shares of marriages that had ended in divorce by marriage duration; all simulation runs for twelve European countries combined

Source: As for Figure 2.

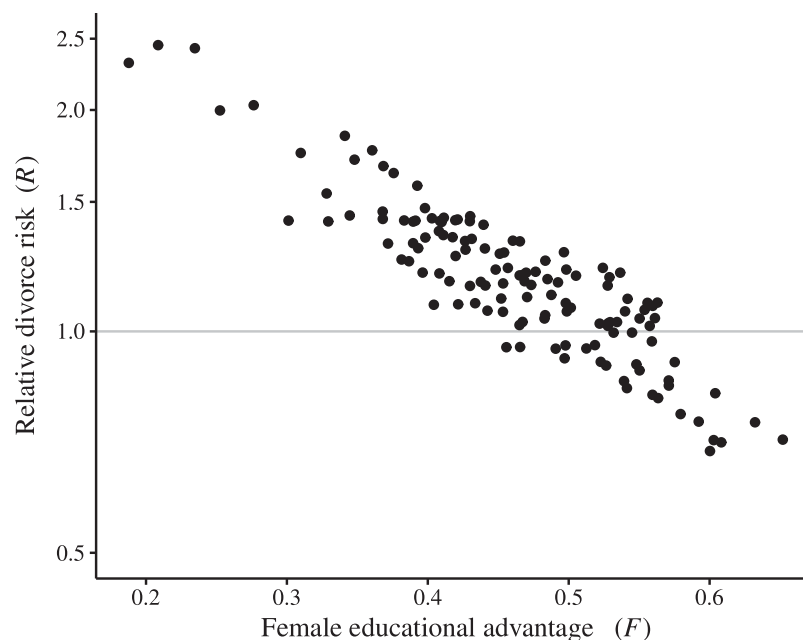


Figure 5 Relative divorce risk (R) for hypogamous ($s_m < s_f$) vs. hypergamous ($s_m > s_f$) marriages and educational advantage of females (F -index); simulated for twelve European countries and eleven marriage cohorts
Notes: We first calculated the average shares of different marriage types across runs within countries and then used these averages to calculate R for each marriage cohort. The y-axis is log-transformed, so that a given ratio and its inverse are shown at the same distance from the equal risk case (i.e., from $R = 1$).

Source: The relative divorce risk is based on the outcomes of our main simulation experiment; the educational advantage of females is based on the global educational trend scenario in the reconstructions and projections of educational attainment by country, year, gender, and five-year birth cohort provided by the IIASA/VID.

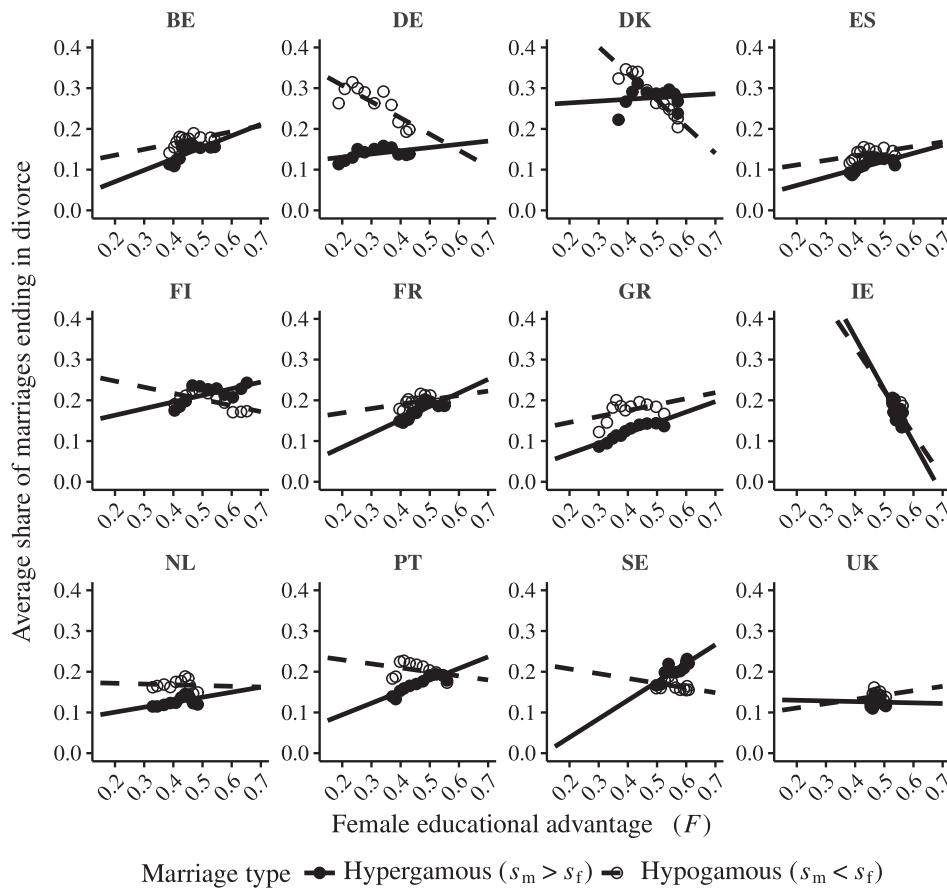


Figure 6 Average shares of hypergamous ($s_m > s_f$) and hypogamous ($s_m < s_f$) marriages that had ended in divorce and educational advantage of females (F -index), by country; simulated for twelve European countries and eleven marriage cohorts

Notes: Trend lines are based on ordinary least square regression models. We first calculated the mean shares for the different marriage types across runs within countries and then calculated the averages of these means across countries.

Source: As for Figure 5.

The association shown in Figure 5 may result from a decrease in the absolute divorce risk among hypogamous marriages, an increase in the absolute divorce risk among hypergamous marriages, or a combination thereof. Figure 6 assesses these alternative processes by plotting the shares of hypogamous and hypergamous marriages that had dissolved against the F -index, separately by country. The figure suggests that the driver of the convergence in divorce risks varied across countries. In one group of countries (Germany, Denmark, Finland, the Netherlands, Portugal, and Sweden), increases in the educational advantage of women reduced the divorce risk among hypogamous marriages and increased it among hypergamous marriages. In a second group (Belgium, Spain, France, and Greece), the divorce risk increased among both marriage types, but this increase was stronger among hypergamous marriages than among hypogamous marriages. Only in Ireland and the UK, was there no clear difference

in the association between F and the divorce risks of the different marriage types.

Finally, the model distinguishes between individuals' cultural and economic resources, represented by agents' educational attainment (s_i) and earnings prospects (y_i). This makes it possible to assess the effects that preferences for each resource have on divorce risks. To this end, Figure 7 compares the outcomes of the basic model with the outcomes of two alternative versions of this model: one in which similarity in education does not affect mate attractiveness (i.e., $w_s^m = w_s^f = 0$) and one in which earnings prospects do not affect mate attractiveness (i.e., $w_y^m = w_y^f = 0$). In the model without educational preferences, the relative divorce risk (R) decreased over successive cohorts, but the intercept was lower and the slope flatter than in the basic model. One explanation for this is that without educational preferences, the effect that the gender-gap reversal in education has on divorce risks occurs indirectly, via agents' preferences for earnings prospects, which are correlated

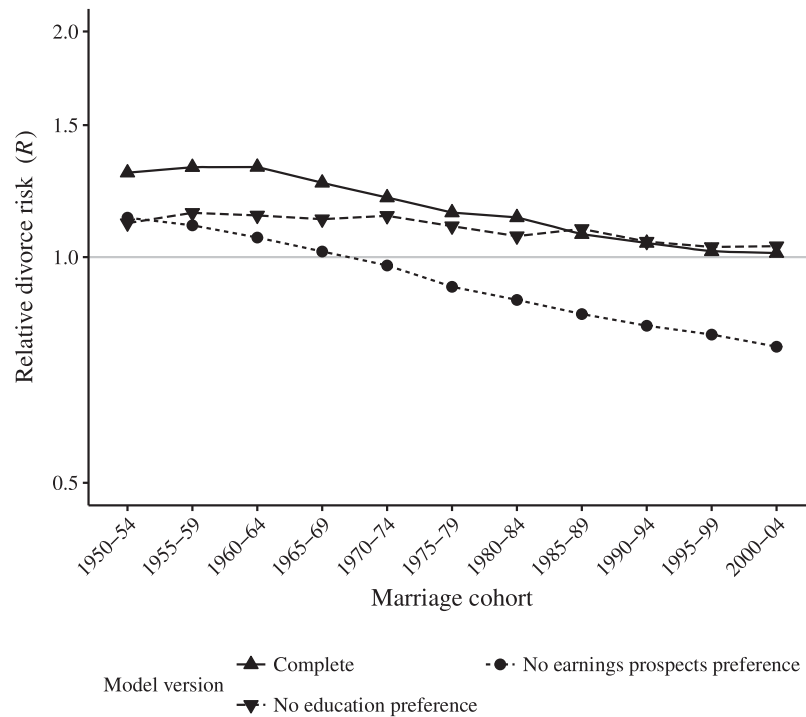


Figure 7 Relative divorce risks (R) of hypogamous ($s_m < s_f$) vs. hypergamous ($s_m > s_f$) marriages, simulated for twelve European countries, by marriage cohort and model version

Notes: We first calculated the average shares of different marriage types across runs within countries and then used these averages to calculate R . The y-axis is log-transformed, so that a given ratio and its inverse are shown at the same distance from the equal risk case (i.e., from $R = 1$).

Source: Own calculations based on the outcomes of our sensitivity simulation experiment.

with educational attainment, and therefore the effect is weaker. In the model without preferences for earnings prospects, the slope was similar to that of the basic model, but the intercept was lower and R fell below one in the 1970–74 marriage cohort. One explanation for this is that earnings prospects and education are imperfectly correlated and that the earnings distribution is usually more compressed among women than among men (see England 2004). In the complete model, some highly educated female agents may thus have had an ‘incentive’ to leave a less educated spouse for another less educated spouse, as long as the new spouse had higher earnings prospects. For highly educated male agents who had a less educated spouse, this was less likely to happen, given that there is less variation in the incomes of less educated women. These differences, in turn, are likely to hamper the decrease in the divorce risk of hypogamous marriages compared with hypergamous marriages.

Discussion and conclusion

The gender-gap reversal in education has had important consequences for patterns of educational assortative mating. In this paper, we have explored some

of the consequences that it may have had for patterns of divorce. The results of our simulation experiments suggest that an increase in the educational attainment of women relative to that of men may lead to a convergence in the divorce risks of hypogamous and hypergamous marriages. The results also suggest that this convergence could occur even if men and women did not have a preference for similarity in cultural resources with their partners. Furthermore, the relative divorce risks of hypogamous and hypergamous marriages might invert, if men and women did not care about the economic resources of their spouses.

The mechanism that we have described focuses on the interplay between people’s partner preferences and changes in the structure of the marriage market. It does not consider that the norms that surround family formation may have changed over time, as suggested by Schwartz and Han (2014). Yet, it seems possible that our opportunity-based mechanism could reinforce the norms-based mechanism described by Schwartz and Han. Schwartz and Han suggested that the number of hypogamous marriages has increased over the years partly because the number of highly educated women has increased relative to that of men. This may have rendered

this type of marriage less deviant and thereby decreased normative pressures that may affect the divorce risk among hypogamous couples. Our mechanism could strengthen this process, by reducing the likelihood of hypogamous couples divorcing, compared with the likelihood of hypergamous couples divorcing. This may further reduce the non-normative character of hypogamous marriages and thereby further reduce their divorce risk. Future research could assess this possibility by introducing marital satisfaction as an additional factor in divorce decisions in the model, where low satisfaction could trigger divorce even in the absence of marital alternatives. The marital satisfaction of spouses could, in turn, be modelled endogenously with respect to the share of marriages that have similar or different educational characteristics to their own union.

As well as norms, the model also neglects a number of other factors that may impinge on divorce decisions. One of the most important factors is the presence of young children, which has been shown to reduce the divorce risk of couples considerably (Lyngstad and Jalovaara 2010) and to reduce the likelihood of remarriage among divorced individuals (Ivanova et al. 2013). If hypogamous and hypergamous marriages differ in their fertility behaviour, this could affect differences in their relative divorce risks and could thus affect the mechanism that we have explored. Future research should therefore extend the model to include such individual- and couple-level factors that may lead to systematic differences in divorce risks between hypogamous and hypergamous marriages, to assess the robustness of the dynamics that we have described.

The mechanism described in this paper potentially applies to all unions, including non-marital cohabitation, which has become more prevalent in recent decades. Yet, one issue that may arise in this respect is that cohabiters are often less committed than married people, which leads to a higher dissolution risk (Forste and Tanfer 1996). This could affect the proposed mechanism if couples with certain educational combinations are more likely to opt for cohabitation than others. Future empirical research should therefore disentangle marriages and cohabitations when exploring the relation between the gender-gap reversal and dissolution risks, to take possible variation in commitment by union type into account.

Finally, our results also offer a new explanation for the increasingly negative educational gradient in divorce risks among women that has been observed in Western countries over recent decades (Härkönen

and Dronkers 2006). According to our model, the gender-gap reversal in education may have reduced the divorce risk among highly educated women in hypogamous marriages, while increasing the divorce risk among less educated women in hypergamous marriages. This may explain at least in part why the average divorce risk among highly educated women has decreased relative to the divorce risk among less educated women.

Notes and acknowledgements

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